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METHODOLOGIES
OF CALCULATION OF NORMATIVE CONSUMPTION OF ELECTRIC AND THERMAL ENERY CONSUMED FOR INTRA-STATION TECNOLOGICAL SUB-CONSTRUCTIONS AND EQUIPMENT IN RESERVE AT THE “HRAZDAN TPP” CJSC

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The present methodologies include principals and normative key data for calculation of normative costs of electric and thermal energy for intra-station technological sub-constructions and equipment in reserve at the ‘Hrazdan TPP” CJSC.

1. General Provisions

1.1 In the conditions of drastic decline in the consumption of electric and thermal energy, portion of energy units, boilers, turbines, generators and their supporting systems and sub-constructions are in reserve regime, instead of designed operating regime.

1.2 Equipment, which does not immediately participate in the generation of electric and thermal energy based on the regime conditions of the power system, is attributed to the reserve equipment.

1.3 The amount of electric and thermal energy consumed for the equipment in reserve, which is not immediately involved in the generation technological cycle and cannot accounted as auxiliary power stipulated by the technological cycle, is considered as the consumption for TPP generation needs.

1.4 Items of TPP electric and thermal energy consumption for generation needs are defined as the following:

1.4.1 Consumption of electric and thermal energy for protection of boiler installations and their supporting equipment, which are in reserve, from freezing, corrosion, and keeping them in operational state.

1.4.2 Consumption of electric and thermal energy for keeping of turbines and their supporting equipment, which are in reserve, in operational state, as well as for protection of their flow-through part from freezing and corrosion.

1.4.3 Consumption of electric and thermal energy to maintain the positive temperature in the generators and their supporting equipment, which are in reserve, as well as to ensure the hermeticity of oiling, hydrogen and water cooling systems.

1.4.4 The portion of electric and thermal energy, consumed for lighting, heating and hot water supply of boiler section and chemical workshop buildings, per boilers in reserve.

1.4.5 The portion of electric and thermal energy, consumed for lighting of turbine section and electric workshop buildings, per turbines in reserve.

1.4.6 The portion of electric and thermal energy, consumed for mazout handling facilities, per boilers in reserve.

1.5 Consumption of electric and thermal energy for mentioned generation needs is mainly done from auxiliary needs systems, stipulated by the technological cycle. They are separated according to the following:

a) meter readings;
b) descriptions and tables based on the tests and calculations;
c) norms of mentioned consumption.

1.6 Electric and thermal energy consumed per the unit of equipment in reserve is consumed according to the following formulas.

$$Q_e = Q_e^h \times \tau, \text{ Gcal},$$

$$Ý_e = N_e \times \tau, \text{ kWh},$$

where Q_e^h - is the hourly consumption of thermal energy for the equipment in reserve, GCal/h.

N_e - power capacity required for the equipment in reserve, kW.

τ - duration of time, the equipment was in reserve, hour.

Depending on the maintenance technology of the equipment, one-time costs are also incurred.

Q_e^h and N_e are normalized for summer and winter seasons.

Estimated summer season is May – October, yet winter season is November – April.

2. Consumption of electric and thermal energy for protection of boiler installations and their supporting equipment, which are in reserve, from freezing, corrosion, and keeping them in operational state

2.1 Mothballing of the boiler through excessive pressure.

2.1.1 Boiler TÃM-104 C.

2.1.1.a. Consumption of electricity for mechanisms' engines and for lighting purposes.

- winter - 81 kW,
- summer - 15 kW

It is determined based on the testing and calculations (attachment 2.1.1 a).

2.1.1.b. Hourly thermal energy consumption for protection from freezing and corrosion.

- winter - 0.5 Gcal/h,
- summer - 0.1 Gcal/h

It is determined based on the testing and calculations (attachment 2.1.1 b).

2.1.2. Boiler ÁÊÇ – 320

2.1.2.a. Hourly electricity consumption for mechanisms' engines and for lighting purposes.

- -winter - 20 kW,
- summer - 15 kW

It is determined based on the testing and calculations (attachment 2.1.2 a).

2.1.2.b. Hourly thermal energy consumption for protection from freezing and corrosion.

- winter - 0.4 Gcal/h,
- summer - 0.08 Gcal/h

It is determined according to the testing and calculations (attachment 2.1.2 b).

2.2 “Dry” mothballing.

2.2.1 Boiler TÃM – 104 Ñ
2.2.1.a. Consumption of electricity for mechanisms’ engines and for lighting purposes.
- winter - 25 kW,
- summer - 15 kW

It is determined based on the testing and calculations (attachment 2.2.1. ?).

2.2.1.b. Hourly thermal energy consumption for protection from freezing and corrosion.

- winter - 0.344 Gcal/h,
- summer - 0 Gcal/h

It is determined based on the testing and calculations (attachment 2.2.1. b).

2.2.2 Boiler ÁÊÇ – 320
2.2.2.a. Consumption of electricity for mechanisms’ engines and for lighting purposes.

- winter - 20 kW,
- summer - 15 kW

It is determined based on the testing and calculations (attachment 2.2.2. ?).

2.2.2.b. Hourly thermal energy consumption for protection from freezing and corrosion.

- winter - 0.27 Gcal/h,
- summer - 0 Gcal/h

It is determined based on the testing and calculations (attachment 2.2.2.b.).

2.3. Mothballing by hydrazine ammonium.

2.3.1. Boiler TÃM – 104 C.

2.3.1.a. Consumption of electricity for mechanisms’ engines and for lighting purposes.

- winter - 25 kW,
- summer - 15 kW

One-time mothballing consumption - 24784 kWh
It is determined based on the testing and calculations (attachment 2.3.1.).

2.3.1.b. Hourly thermal energy consumption for protection from freezing and corrosion.

- winter - 0.344 Gcal/h,
- summer - 0 Gcal/h

One-time mothballing consumption – 35.26 Gcal
It is determined based on the testing and calculations (attachment 2.3.1.).

2.3.2. Boiler ÁÊÇ – 320

2.3.2.a. Consumption of electricity for mechanisms’ engines and for lighting purposes.

- winter - 20 kW,
- summer - 15 kW

One-time mothballing consumption – 4656 kWh
It is determined based on the testing and calculations (attachment 2.3.2.).

2.3.2.b. Hourly thermal energy consumption for protection from freezing and corrosion.

- winter - 0.27 Gcal/h,
- summer - 0 Gcal/h

One-time mothballing consumption – 24.14 Gcal
It is determined based on the testing and calculations (attachment 2.3.2.).

2.4. Mothballing using inhibitors.
The consumption is basically the same as in case of he mothballing by hydrazine ammonium.

3. Consumption of electric and thermal energy for keeping of turbines and their supporting equipment, which are in reserve, in operational state, as well as for protection of their flow-through part from freezing and corrosion

3.1. Mothballing of the turbine by pre-heated air.
3.1.1. Turbine K – 200 – 130
3.1.1.a. Consumption of electricity for mechanisms’ engines and for lighting purposes.

- winter - 32.5 kW,
- summer – 22.5 kW

It is determined based on the testing and calculations (attachment 3.1.1.).

3.1.1.b. Hourly thermal energy consumption for protection of flow-through part of the turbine from freezing and corrosion.

- winter - 0.039 Gcal/h,
- summer - 0.039 Gcal/h

It is determined based on the testing and calculations (attachment 3.1.1.).

3.1.2. Turbine ÏT – 50 – 130/7, T – 100 – 130

3.1.2.a. Consumption of electricity for mechanisms’ engines and for lighting purposes.

- winter - 32.5 kW,
- summer – 22.5 kW

3.1.2.b. Hourly thermal energy consumption for protection of flow-through part of the turbine from freezing and corrosion.

- winter - 0.03 Gcal/h,
- summer - 0.03 Gcal/h

It is determined based on the testing and calculations (attachment 3.1.2.).

3.2. Mothballing of the turbine using inhibitors.

One-time consumption of electric and thermal energy is determined based on the mothballing plan. Consumption of the electric energy for lighting purposes is considered as a constant consumption.

4. Consumption of electric and thermal energy for maintaining of positive temperature in the generators and their supporting equipment, which are in reserve, as well as for ensuring the hermeticity of oiling, hydrogen and water cooling systems

4.1. Generator T? B – 200 M,
4.1.a. Consumption of electricity for mechanisms' engines.
- winter - 27 kW,
- summer – 27 kW

4.1.b. Hourly thermal energy consumption for ensuring the hermeticity of oiling, hydrogen and water cooling systems.
- winter - 0.025 Gcal/h,
- summer - - Gcal/h

It is determined based on the testing and calculations (attachment 4.1.).

4.2 In the non-block part of TPP, the capacity of the pump of the generator filled by the hydrogen is 6 kW.

5. The portion of electric and thermal energy, consumed for lighting, heating and hot water supply of boiler section and chemical workshop buildings, which falls on boilers in reserve

Consumption per one boiler is as follows.
5.1. Boiler section (BTW- 1,2)
5.1.a. Consumption of electricity for mechanisms' engines and for lighting purposes.

BTW- 1 - winter - 3.52 kW,
- summer -1.92 kW

BTW- 2 - winter - 5.4 kW,
- summer – 2.4 kW

5.1.b. Hourly thermal energy consumption for heating and hot water supply of boilers in reserve.

BTW- 1 - winter - 0.20 Gcal/h x boiler
- summer - - Gcal/h x boiler

BTW- 2 - winter - 0.42 Gcal/h x boiler
- summer - - Gcal/h x boiler

5.2. Chemical workshop

5.2.a. Consumption of electricity for mechanisms’ engines and for lighting purposes (average total capacity).

TTM – 104c - winter – 63.6 kW/boiler
- summer – 50.0 kW/boiler

ÁÊÇ - 320 - winter – 31.8 kW/boiler
- summer – 25.0 kW/boiler

5.2.b. Hourly thermal energy consumption for heating and hot water supply of chemical workshop building.

TTM – 104C - winter – 0.0392 Gcal/h x boiler
- summer – 0.0056 Gcal/h x boiler

??? - 320 - winter – 0.0196 Gcal/h x boiler
- summer – 0.0028 Gcal/h x boiler

It is determined based on the testing and calculations (attachment 5.1.).

6. The portion of electric and thermal energy, consumed for lighting of turbine section and electric workshop buildings, per turbines in reserve

6.1. Turbine section (BTW- 1, BTW- 2)
6.1.a. Consumption of electricity for mechanisms’ engines and for lighting (average total capacity)

- winter ÏÒ- 50, T - 100 - 24.6 kW/ turbine
K -200 - 58.2 kW/ turbine

- summer ÏÒ- 50, T - 100 - 18,6 kW/ turbine
K -200 - 43,2 kW/ turbine

6.1.b. Hourly thermal energy consumption for heating of turbines and electric workshop building during the winter.

ÏÒ- 50, T - 100 - 0.273 Gcal/h x turbine
K -200 - 0.454 Gcal/h x turbine

It is determined based on the testing and calculations (attachment 6.).

7. The portion of electric and thermal energy, consumed for mazout handling facilities, which falls on boilers in reserve

7.1. Consumption of electricity for mechanisms' engines and for lighting (average total capacity)

- winter ÁÊÇ – 320 - 25.6 kW/ boiler
  TTM – 104 - 51.1 kW/ boiler

- summer ÁÊÇ – 320 - 11.9 kW/ boiler
  TTM – 104 - 23.9 kW/ boiler

7.2. Hourly thermal energy consumed in mazout handling facilities, which falls on boilers in reserve.

- winter ÁÊÇ – 320 - 0.006 Gcal/h x boiler
  TTM – 104 - 0.012 Gcal/h x boiler

- summer ÁÊÇ – 320 - 0.004 Gcal/h x boiler
  TTM – 104 - 0.007 Gcal/h x boiler

It is determined based on the testing and calculations (attachment 7.).

8. The order of calculation of normative consumption of electric and thermal energy for the equipment in reserve

8.1 The key normative data for the calculation of normative consumption of electric and thermal energy for the equipment in reserve are data for consumption in sections 2-7, the summary of which is presented in the Table 1.

8.2 Normative consumption for the duration of being the reserve is calculated using the formulas in the Table 1.6.

8.3 Examples of calculations of winter and summer normative consumption are presented in the Tables 2 and 3.

8.4 The following reserve regimes are assigned depending on the boiler stop duration.

- up to 30 days – "dry" stop or by excessive pressure
- more than 30 days – mothballing by hydrazine ammonium method

8.5 Turbines that are in reserve for 7 days and more are subject to mothballing by pre-heated air. Mothballing using inhibitors is presented as a prospective regime.

Normative consumption of electric and thermal energy required for keeping the “Hrazdan” TPP back-up equipment in operational state

Table 1

N Á/Ï	Name of the equipment, reserve regime	Consumption of thermal energy, Gcal/h		Consumption of electric energy, kW		Note
		winter	summer	winter	summer	
1.	Boiler TTM – 104C					
1.1.	Mothballing by excessive pressure	0.5	0,1	81	15	
1.2.	“Dry” mothballing	0,344	0	25	15	
1.3.	Mothballing by hydrazine ammonium method	0.344, 35.26*	0, 32.26*	25, 24784*	15, 24784*	*One-time consumption, Gcal, kWh
2.	Boiler ÁÊÇ - 320					
2.1.	Mothballing by excessive pressure	0,4	0,08	20	15	
2.2.	“Dry” mothballing	0,27	0	20	15	
2.3.	Mothballing by hydrazine ammonium method	0.27, 24.14*	0, 24.14*	20, 4656*	15, 4656*	*One-time consumption, Gcal, kWh
3.	Turbine K - 200 - 130					
3.1.	Mothballing by pre-heated air	0.039	0.039	32.5	22.5	
3.2.	Mothballing using inhibitors	-	-	25*	15*	*One-time consumption based on the mothballing plan is also calculated
4.	Turbine ÏÒ – 50					
4.1.	Mothballing by pre-heated air	0,03	0,03	32.5	22.5	
4.2.	Mothballing using inhibitors	-	-	25*	15*	*One-time consumption based on the mothballing plan is also calculated
5.	Turbine T - 100					
5.1.	Mothballing by pre-heated air	0,03	0,03	32.5	22.5	
5.2.	Mothballing using inhibitors	-	-	25*	15*	*One-time consumption based on the mothballing plan is also calculated
6.	Generator TÂB - 200 M	0,025	-	27	27	
7.	Generators TBô -60 – 2 and TBô - 100 - 2	-	-	6	6	Calculated only for one generator
8.	Boiler section and chemical workshop consumption per one boiler					
8.1.	TÃM – 104 C	0.42 + 0.0392=0.4592	0.0056	5.4+63.6=69.0	2.4+50.0=52.4	
8.2.	ÁÊÇ – 320	0.20 + 0.0196=0.2196	0.0028	3.52+31.8=35.32	1.92+25.0=26.92	
9.	Turbine section and electrical workshop consumption per one boiler					
9.1.	K – 200	0.454	-	58.2	43.2	
9.2.	ÏÒ - 50 and T - 100	0.273	-	24.6	18.6	
10.	Fuel handling facility consumption per one boiler					
10.1.	TÃM - 104 C	0.012	0.007	51.1	23.9	
10.2.	ÁÊÇ - 320	0.006	0.004	25.6	11.9	

N Á/Ï	Name of the equipment, reserve regime	Hours in reserve	Consumption of thermal energy		Consumption of electric energy		Note
			winter, Gcal/h	total, Gcal	winter, kW	total, kWh	
1.	Boiler TTM – 104C						
1.1.	Mothballing by excessive pressure	1500	0.5	750	81	121500	
1.2.	“Dry” mothballing	-	0.344	0	25	-	
1.3.	Mothballing by hydrazine ammonium method	-	0.344, 35.26*	0	25, 24784*	-	*one-time consumption, Gcal, kWh
2.	Boiler ÁÊÇ - 320						
2.1.	Mothballing by excessive pressure	2100	0.4	840	20	42000	
2.2.	“Dry” mothballing	700	0.27	189	20	14000	
2.3.	Mothballing by hydrazine ammonium method	-	0.27, 24.14*		20, 4656*	-	*one-time consumption, Gcal, kWh
3.	Turbine K - 200 - 130						
3.1.	Mothballing by pre-heated air	1500	0.039	58.5	32.5	48750	
3.2.	Mothballing using inhibitors	-	-	-	25*	-	*One-time consumption based on the mothballing plan is also calculated
4.	Turbine ÏÒ – 50						
4.1.	Mothballing by pre-heated air	700	0.03	21	32.5	22750	
4.2.	Mothballing using inhibitors	-	-	-	25*	*	*One-time consumption based on the mothballing plan is also calculated
5.	Turbine T – 100						
5.1.	Mothballing by pre-heated air	1400	0.03	42	32.5	45500	
5.2.	Mothballing using inhibitors	-	-	-	25*	*	*One-time consumption based on the mothballing plan is also calculated
6.	Generator TÃB - 200 M	1500	0.025	37.5	27	40500	
7.	Generators TBô -60 – 2 and TBô - 100 - 2	744	-	0	6	4464	Calculated only for one generator
8.	Boiler section and chemical workshop consumption per one boiler						
8.1.	TÃM - 104 C	1500	0.42 + 0.0392=0.4592	689	5.4+63.6=69.0	103500	
8.2.	ÁÊÇ - 320	2800	0.20 + 0.0196=0.2196	615	3.52+31.8=35.32	98896	
9.	Turbine section and electrical workshop consumption per one boiler						
9.1.	K – 200	1500	0.454	681	58.2	87300	
9.2.	ÏÒ – 50 and T – 100	2100	0.273	573	24.6	51660	
10.	Fuel handling facility consumption per one boiler						
10.1.	TÃM – 104 C	1500	0.012	18	51.1	76550	
10.2.	ÁÊÇ – 320	2800	0.006	17	25.6	71680	

Normative consumption of electric and thermal energy required to keep “Hrazdan TPP’ equipment, which is in reserve, in operational state (December 200 , (example))

Table 2

Normative consumption of electric and thermal energy required to keep “Hrazdan TPP’ equipment, which is in reserve, in operational state (December 200 , (example))

Table 3

N Á/Ï	Name of the equipment, reserve regime	Hours in reserve	Consumption of thermal energy		Consumption of electric energy		Note
			summer, Gcal/h	total, Gcal	summer, kW	total, kWh	
1.	Boiler TTM – 104C						
1.1.	Mothballing by excessive pressure	500	0.1	50	15	7500	
1.2.	“Dry” mothballing	1000	0	0	15	15000	
1.3.	Mothballing by hydrazine ammonium method	-	0. 32.26*	0	15, 24784*	-	*one-time consumption, Gcal, kWh
2.	Boiler ÁÊÇ - 320						
2.1.	Mothballing by excessive pressure	700	0.08	56	15	10500	
2.2.	“Dry” mothballing	2100	0	0	15	31500	
2.3.	Mothballing by hydrazine ammonium method	-	0, 24.14*	0	15, 4656*	-	*one-time consumption, Gcal, kWh
3.	Turbine K - 200 - 130						
3.1.	Mothballing by pre-heated air	1500	0.039	58.5	22.5	33750	
3.2.	Mothballing using inhibitors	-	-	-	15*	-	*One-time consumption based on the mothballing plan is also calculated
4.	Turbine ÏÒ – 50						
4.1.	Mothballing by pre-heated air	700	0.03	21	22.5	15750	
4.2.	Mothballing using inhibitors	-	-	-	15*	-	*One-time consumption based on the mothballing plan is also calculated
5.	Turbine T – 100						
5.1.	Mothballing by pre-heated air	1400	0.03	42	22.5	31500	
5.2.	Mothballing using inhibitors	-	-	-	15*	-	*One-time consumption based on the mothballing plan is also calculated
6.	Generator TÃB - 200 M	1500	-	0	27	40500	
7.	Generators TBô -60 – 2 and TBô - 100 - 2	720	-	0	6	4320	Calculated only for one generator
8.	Boiler section and chemical workshop consumption per one boiler						
8.1.	TÃM - 104 C	1500	0.0056	8.4	2.4+50.0=52.4	78600	
8.2.	ÁÊÇ - 320	2800	0.0028	7.8	1.92+25.0=26.92	75376	
9.	Turbine section and electrical workshop consumption per one boiler						
9.1.	K – 200	1500	-	0	43.2	64800	
9.2.	ÏÒ - 50 and T – 100	2100	-	0	18.6	39060	
10.	Fuel handling facility consumption per one boiler						
10.1.	TÃM - 104 C	1500	0.007	10.5	23.9	35850	
10.2.	ÁÊÇ - 320	2800	0.004	11.2	11.9	33320	

ATTACHMENTS

Attachment 2.1.1.a

Consumption of electric energy during the mothballing of ??? -104C boiler by excessive pressure

During mothballing of the boiler by excessive pressure, the penetration of the oxygen into the water-steam cycle is excluded and corrosion is prevented (2,9,10).

The excessive pressure in the boiler is maintained either by supplied steam or by circulating pumps. Pumps are used during the winter, when it is necessary to ensure safe water circulation in the boiler water-steam cycle in order to eliminate freezing in the bent zones.

During the winter period, there is the following electric consumption (taking into account the load factor):

lighting (during the inspection) and for control equipment - $N_{É}^{c}$ =25 kW,

boiler water circulating pump – N_2 =56 kW.

During the summer period, the electricity is consumed only for lighting (15 kW).

Thus, consumption of electricity per one boiler is:

winter – $N_w = N_1 + N_2 = 25 + 56 = 81$ kW

summer - Ns = 15 kW

Attachment 2.1.1.b

Consumption of thermal energy during the mothballing of ??? -104C boiler by excessive pressure

Boiler installation thermal energy consumption has been determined according to the results of the testing carried out by “Hrazdan TPP” (10,11,12,13,14).

For winter testing conditions, there is the following thermal energy consumption:

Losses from the external surface.

Qex = 0.18 Gcal/h,

Leakage from boiler hot water valves and sampling pumps.

Qv = 0.13 Gcal/h,

Heat loss as a result of unpreasureized gas and air circuit valves.

Qg = 0.688 Gcal/h.

Thus, hourly thermal energy consumption per one boiler is as follows:

Q = Qex + Qv + Qg = 0.18+0.13+0.688=0.998Gcal/h, Based on the boiler average temperature conditions, winter consumption is accepted to be 0.5 of the above mentioned consumption, that is Q=0.5*0.998=0.5Gcal/h, yet summer consumption is 0.1 of the consumption, that is Q=0.1*0.998=0.1Gcal/h.

Attachment 2.1.2.a.

Consumption of the electric energy during the mothballing of ???-320 boiler by excessive pressure

During mothballing of the boiler by excessive pressure, the penetration of the oxygen into the water-steam cycle is excluded and as a result the corrosion is prevented (2, 12, 15).

The excessive pressure in the boiler is maintained through supplied steam.

During the winter and summer periods, there is the following electric consumption (taking into account the load factor):

lighting (during the inspection) and for control equipment – N_1 =20 kW for winter, N_1 =15 kW for summer.

Attachment 2.1.2.b.

Consumption of thermal energy during the mothballing of boiler ???-320 by excessive pressure

Boiler installation thermal energy consumption has been determined according to the results of the testing carried out by "Hrazdan TPP" (2 ,12 ,15).

For winter testing conditions there are the following thermal energy consumption:

Losses from the external surface.

Qex = 0.14 Gcal/h,

Leakage from boiler hot water valves and sampling pumps.

Qv = 0.13 Gcal/h,

Heat loss as a result of unpreasureized gas and air circuit valves.

Qg = 0.54 Gcal/h.

Thus, hourly thermal energy consumption per one boiler is as follows:

Q = Qex + Qv + Qg = 0.14+0.13+0.54=0.81Gcal/h,

Based on the boiler average temperature conditions, the winter consumption is assumed to be 0.5 of the above mentioned consumption, that is Q=0.5*0.81=0.4Gcal/h, yet summer above mentioned consumption is 0.1 of the consumption, that is Q=0.1*0.81=0.08Gcal/h.

Attachment 2.2.1.a.

Consumption of the electric energy during the "dry" mothballing of ??? -104 boiler mechanisms' engines and lighting

In case of dry mothballing, the emptying of boiler water and steam cycle is carried out after the boiler is shut down, when the boiler inside pressure is 8 – 10 bar. Because of the accumulated thermal energy by the metal and heat insulation of the boiler, the internal surface of the steam and water cycle is unwatered and the bend corrosion is prevented.

During the winter and summer periods, the electricity is consumed mainly for lighting purposes (during the inspection).

Consumption of the electricity per one boiler is (taking into account the load factor) the following:

$N=N_1=25$ kW – for winter, and

$N=N_1=15$ kW – for summer.

Attachment 2.2.1.b.

Consumption of thermal energy during the "dry" mothballing of ??? -104 boiler

During the dry mothballing, the thermal energy is consumed only during the winter to compensate the heat loss from gas and air valves (10, 11, 12).

$$Q=0.5* Q_g = 0.5*0.688=0.344\text{Gcal/h}$$

Attachment 2.2.2.a.

Consumption of the electric energy during the "dry" mothballing of ?? ?-320 boiler

The electricity is consumed mainly for lighting.
Consumption (12, 15) of the electricity per one boiler is the following (taking into account the load factor):

$N=N_1=20$ kW – for summer.

Attachment 2.2.2.b.

Consumption of the thermal energy during the "dry" mothballing of ? ? ?-320 boiler

During the dry mothballing, the thermal energy is consumed only during the winter to compensate the heat loss from gas and air valves (12, 15).

$$Q=0.5* Q_g = 0.5*0.54=0.27\text{Gcal/h}$$

Attachment 2.3.1.

Calculation of thermal and electric energy during the hydrazine ammonium mothballing of ??? -104C boiler

The calculation is based on the mothballing procedure presented in (10).

During the mothballing, there is one-time consumption of electric and thermal energy for pumps, ventilation fan, smoke extraction device, heating of boiler water and metal, as well as constant consumption for lighting per boiler, and to compensate the heat loss from gas and air cycle.

One-time consumption of the electric energy during 16-hour mothballing is calculated in the following Table A1.

Table A1

N	Name of the equipment	Brand	El. capacity, kW	Quantity	Load factor (estimated)	Actual capacity, kW	Consumption of electricity, kWh
1.	Ventilation fan (I exit)	? ? ? -32?	625	2	0.5	625	10 000
2.	Smoke extraction device (I exit.)	? - 25x2? ?	860	2	0.5	860	13 760
3.	Cycling pump	BVS-1000	54	1	1.0	54	864
4.	Other pumps					10	160
	Total					1549	24784

In addition to the one-time consumption of the electricity for the mothballing, the electricity is consumed also for the lighting of the boiler during the whole duration of being in reserve. Average consumption for winter is 25 kW, and for summer is 15 kW.

The amount of thermal energy required to heat the boiler water is as follows:

$Q_w = C_w * M_w * (t_2 - t_1)$, kcal,

where $C_w = 1$kcal/kg $^{\hat{u}}$C – water specific heat,

$M_w = 100*10^3$ kg – boiler water weight,

$t_1 = 15\,^oC$ - boiler water initial temperature,

$t_2 = 195\,^oC$ – heated boiler water temperature.

$Q_w = 100*10^3*(195-15)=18*10^6$kcal=18Gcal

The thermal energy required to heat the metal of the boiler is as follows:

$Q_m = C_m * M_m * (t_2 - t_1)$, kcal,

where $M_m = 571*10^3$ kg – heated metal weight

$C_m = 0.12$ kcal/kg^{o}C – metal specific heat

$Q_m = 0.12*571*(195-15)*10^3=12.3*10^6$kcal=12.3Gcal.

The boiler installation other thermal energy consumption, based on the (10, 11, 12, 13, 14), is the following estimated amount:

Losses from the external surface.

Qex = 0.18 Gcal/h,

Leakage from boiler hot water and steam valves

Qv = 0.13 Gcal/h,

Heat loss as a result of unpreasureized gas and air circuit valves.

Qg = 0.688 Gcal/h.

Out of mentioned consumption,

Qex + Qv = 0.18+0.13=0.31Gcal/h

is available during the duration of the mothballing (τ = 16 hours) and as one-time consumption amounts to:

Qo-t = τ * 0.31 = 16*0.31 = 4.96 Gcal.

One-time thermal energy consumption for mothballing is:

Qmb= Qw + Qm + Qo-t = 18+12.3+4.96=35.26Gcal.

0.5* Qg = 0.344 Gcal/h is available during the winter, during the whole duration of being in reserve, if “dry” mothballing does not follow the hydrazine ammonium mothballing.

Attachment 2.3.2

Calculation of thermal and electric energy consumption during the hydrazine ammonium mothballing of ???-320 boiler

The calculation is done for cold boiler.

During the mothballing, there is one-time consumption of electric and thermal energy for pumps, ventilation fan, smoke extraction device, heating of boiler water and metal, as well as constant consumption for lighting per boiler, and to compensate the heat loss from gas and air cycle.

Consumption of the electric energy during 8-hour mothballing is calculated in the following Table A2.

Table A2

N	Name of the equipment	Brand	El. capacity, kW	Quantity	Load factor (estimated)	Actual capacity, kW	Consumption of electricity, kWh
1.	Ventilation fan (I exit)	ÂÄÍ-20	170	2	0.5	170	1360
2.	Smoke	Ä-21,5 x 2	400	2	0.5	400	3200

	extraction device						
3.	Hydrazine and water pumps					12	96
Total						582	4656

In addition to the one-time consumption of the electricity consumed for the mothballing, the electricity is consumed also for the lighting of the boiler during the whole duration of being in reserve. Average consumption for winter is 20 kW and for summer is 15 kW (taking into account load factor).

The amount of the thermal energy required to heat the boiler water is as follows:

$$Q_w = C_w*m_w*(t_2-t_1), \text{ kcal},$$

where C_w = 1kcal/kg ^{û}C – water specific heat,

$m_w = 83*10^3$ kg – boiler water weight,

$t_1 = 15\ ^oC$ - boiler water initial temperature,

$t_2 = 195\ ^oC$ – heated boiler water temperature.

$Q_w = 83*10^3*(195-15)=14.94*10^6$kcal=14.94Gcal

Thermal energy required to heat the metal of the boiler is as follows:

$Q_m = C_m*m_m*(t_2-t_1)$, kcal,

where $m_m = 326*10^3$ kg – heated metal weight

$C_m = 0.12$ kcal/kg^{o}C – metal specific heat

$Q_m = 0.12*326*(195-15)*10^3=7.04*10^6$kcal=7.04Gcal.

The boiler installation other thermal energy consumption, based on the (15), are the following estimated amounts:

Losses from the external surface.

Q_{ex} = 0.14 Gcal/h,

Leakage from boiler hot water and steam valves

Q_v = 0.13 Gcal/h,

Heat loss as a result of unpreasureized gas and air circuit valves.

Q_g = 0.54 Gcal/h.

Out of mentioned consumption,

$Q_{ex} + Q_v$ = 0.14+0.13 = 0.27Gcal/h

is available during the duration of the mothballing (τ = 8 hours) and as one-time consumption amounts to:

$Q_{o-t} = \tau * 0.31 = 8*0.27 = 2.16$ Gcal.

One-time thermal energy consumption for mothballing is:

Qmb= Qw + Qm + Qo-t = 14.94+7.04+2.16 = 24.14 Gcal.

0.5* Qg = 0.27 Gcal/h is available during the winter, during the whole duration of being in reserve.

Attachment 3.1.1

In case of mothballing by hot air, consumption of the electric and thermal energy for keeping of K – 200 – 130 turbine, which is in reserve, in operational state, as well as for protection of its flow-through part from freezing and corrosion

3900 m^3/h of air heated in the air-heater up to 50 ^oC is blown into the flow-through part of the turbine, which prevents from the steam condensation on the metal surface, as well as evaporates water accumulated in the bends, and prevent from freezing.

The thermal energy consumed to heat the air is equal to 0.039 Gcal/h, yet electric energy consumed for the fan is equal to 7.5 kW, consumed for lighting is equal to 25 kW for winter and 15 kW for summer. Total consumption for winter is 32.5 kW, and for summer is 22.5 kW (taking into account load factor).

Attachment 3.1.2

In case of mothballing by hot air, consumption of the electric and thermal energy for keeping of ÏÒ -50 - 130/ 7 and T - 100 -130 turbine, which is in reserve, in operational state, as well as for protection of its flow-through part from freezing and corrosion

3300 m^3/h of air heated in the air-heater up to 50 ^oC is blown into the flow-through part of the turbine, prevents form the steam condensation on the metal surface, as well as evaporates water accumulated in the bends, and prevents from freezing.

Consumption of thermal and electric energy is the following.

The electric energy consumed for lighting each turbine is equal to 25 kW for winter and 15 kW for summer, consumed for fan – 7.5 kW. Total consumption for winter is 32.5 kW, and for summer is 22.5 kW (taking into account load factor).

The thermal energy consumed to heat the air for each turbine is equal to 0.03 Gcal/h.

Attachment 4.1

Consumption of electric and thermal energy to maintain the positive temperature in the TÃÂ - 200 M generator and its supporting equipment, which are in reserve, as well as to ensure the hermeticity of oiling, hydrogen and water cooling systems

In order to maintain the stator windings of the back-up generators undamaged, the condensate is constantly circulated by 22 kW pumps.

The back-up generators, with 50% of probability, are filled with the hydrogen. To prevent the outflow of the hydrogen, the rotary seals of the generators are supplied with the oil with 10 kW pumps.

Electric consumption per one generator is as follows:

22 + 0.5*10 = 27 kW

In order to maintain stable temperature regime of the generator, to prevent the formation of dew and the freezing during the winter period, the water circulating in the winding of the generator is heated by reserve steam, which requires 0.025 Gcal/h of thermal energy consumption (12).

Attachment 5

Calculation of the electric and thermal energy, consumed for lighting, heating and hot water supply of boiler section and chemical workshop buildings, for the boilers in reserve

Consumption of the thermal energy to heat BTW- 1 and BTW- 2 main buildings is calculated using the following formula:

$$Q = q \cdot V \cdot (t_i - t_o), \text{ kcal/h}$$

where q is the specific thermal energy loss from 1 m^3 of the volume of the building (3), kcal/ m^3 h ûC,

V – volume of the building, m^3

t_i , t_o – average temperature inside the building and outside the building, ûC,

Using the corresponding data, we will get the following:

$$Q_{\text{ - 1}} = 0{,}35 \cdot 280\,000 \cdot [16 - (-5)] = 2\,058\,000 \text{ kcal/h} = 2.06 \text{ Gcal/h}$$
$$Q_{\text{BTW- 2}} = 0{,}35 \cdot 450\,000 \cdot [16 - (-5)] = 3\,308\,000 \text{ kcal/h} = 3.31 \text{ Gcal/h}$$

Half of $Q_{\text{BTW- 1}}$ and $Q_{\text{BTW- 2}}$ is estimated as consumption of boiler section.

$$Q^{boil.}_{BTW-1} = 0.5 \cdot Q_{\text{BTW- 1}} = 1.03 \text{ Gcal/h}$$
$$Q^{boil.}_{BTW-2} = 0.5 \cdot Q_{\text{BTW- 2}} = 1.66 \text{ Gcal/h}$$

In order to determine the heat per one boiler, it is necessary to divide the consumption of the boiler section by number of boilers.

$$Q^{\text{ÁÊÇ}}_{BTW-1} = Q^{\text{boil.}}_{BTW-1} / 5 = 1.03 / 5 = 0.20 \text{ Gcal/h boiler}$$
$$Q^{\text{ÒÃÌ -104}}_{BTW-2} = Q^{\text{boil.}}_{\text{Î}BTW-2} / 4 = 1.66 / 4 = 0.42 \text{ Gcal/h boiler}$$

Consumption of electric energy for lighting BTW- 1 boiler section is determined based on the estimate of 80 bulbs of 0.4 kW and 0.3 load factor.

$$N^{boil.1.}_{BTW-1} = 80 \cdot 0.4 \cdot 0.3 = 9.6 \text{ kW},$$

Correspondingly for one boiler – 9.6/5 = 1.92 kW.

Consumption of the electric energy for air-heater fans in the BTW- 1 boiler section is estimated as:

$$N^{boiler.a-h.}_{BTW-1} = 8 \text{ kW},$$

Consumption of electric energy for air-heaters and lighting in the BTW- 1 boiler section is:

$$N_{BTW-1}^{boil..} = N_{BTW-1}^{boil.l} + N_{BTW-1}^{boil.a-h.} = 9.6 + 8 = 17.6 \text{ kW}$$

Consumption of the electric energy for lighting of BTW- 2 boiler section is determined based on the estimate of 80 bulbs of 0.4 kW and 0.3 load factor.

$$N_{BTW-2}^{boil.1.} = 80 \cdot 0.4 \cdot 0.3 = 9.6 \text{ kW},$$

Correspondingly for one boiler – 9.6/4 = 2.4 kW.

Consumption of the electric energy for air-heater fans in the BTW- 2 boiler section is estimated as:

$$N_{BTW-2}^{boiler.a-h.} = 12 \text{ kW},$$

Consumption of electric energy for air-heaters and lighting in the BTW- 2 boiler section is:

$$N_{BTW-2}^{boil..} = N_{BTW-2}^{boil.l} + N_{BTW-2}^{boil.a-h.} = 9.6 + 12 = 21.6 \text{ kW}$$

In order to determine amount of electric energy per one boiler, it is necessary to divide consumption of boiler section by number of boilers.

$$Q_{BTW\ 1}^{ÁÊÇ} = Q_{BTW\ 1}^{boil.} / 5 = 17.6 / 5 = 3.52 \text{ kW/ boiler}$$

$$Q_{BTW-2}^{ÒÃ Ì\ -104} = Q_{BTW-2}^{boil.} / 4 = 21.6 / 4 = 5.4 \text{ kW boiler}$$

Consumption of electric and thermal energy for chemical workshop are accepted based on the (18) and are as follows:

Consumption of the electric energy, N_{chem}
winter – 413.3 kW
summer – 325.6 kW

Consumption of the thermal energy, Q_{chem}
winter – 0.255 Gcal/h
summer – 0.037 Gcal/h

In order to determine the consumption of electric and thermal energy per one boiler, it is necessary to divide chemical workshop consumption by 4 ??? -104 type boilers and 5 ? ? ? - 320 type boilers relative to their productivity.

Total output of the boilers is:

$$\Sigma D = 5 * D^{???\ -320} + 4 * D^{???\ -104} = 5 * 320 + 4 * 640 = 4160 \text{ t/h}$$

The share of total consumption per one ÁÊÇ - 320 type boiler is 320/4160, yet the share of total consumption per one ÒÃ Ì -104 type boiler is 640/4160.

The consumption of electricity is as follows:

for winter $N_{\text{chem}}^{\text{ÁÊÇ -320}}$ = 320/4160 · 413.4 = 31.8 kW /boiler

$N_{\text{chem}}^{\text{ÒÃÌ -104}}$ = 640/4160 · 413.4 = 63.6 kW /boiler

for summer $N_{\text{chem}}^{\text{ÁÊÇ -320}}$ = 320/4160 · 325.6 = 25.0 kW /boiler

$N_{\text{chem}}^{\text{ÒÃÌ -104}}$ = 640/4160 · 325.6 = 50.0 kW /boiler

The consumption of the thermal energy is as follows:

for winter $N_{\text{chem}}^{\text{ÁÊÇ -320}}$ = 320/4160 · 0.255 = 0.0196 Gcal/ h boiler

$N_{\text{chem}}^{\text{ÒÃÌ -104}}$ = 640/4160 · 0.255 = 0.0392 Gcal/ h boiler

for summer $Q_{\text{chem}}^{\text{ÁÊÇ -320}}$ = 320/4160 · 0.037 = 0.0028 Gcal/ h boiler

$Q_{\text{chem}}^{\text{ÒÃÌ -104}}$ = 640/4160 · 0.037 = 0.0056 Gcal/ h boiler

Attachment 6

The portion of electric and thermal energy, consumed for lighting of turbine section and electric workshop buildings, per back-up turbines

The consumption of the thermal energy to heat BTW- 1 and BTW- 2 main buildings was calculated in the Attachment 5 and is as follows:

$Q_{\text{BTW- 1}}$ = 2.06 Gcal/h
$Q_{\text{BTW- 2}}$ = 3.31 Gcal/h

The half of above quantities is estimated as consumption of the turbine section.

$Q_{BTW-1}^{turb.}$ = 0.5 $Q_{\text{BTW- 1}}$ = 1.03 Gcal/h,

$Q_{BTW-2}^{turb.}$ $Q_{\text{BTW- 2}}$ = 0.5 $Q_{\text{BTW- 2}}$ = 1.66 Gcal/h

In order to determine the thermal energy per one turbine, it is necessary to divide total turbine sections consumption by the number of turbines.

$Q_{BTW\ 1}^{\text{ÏÒ-50,Ò-100}} = Q_{\text{Îï²}-1}^{turb.}$ / 4 = 1.03 / 4 = 0.26 Gcal/ h turbine

$Q_{\text{BTW -2}}^{\text{K 200}} = Q_{\text{BTW -2}}^{\text{turb.}}$ / 4 = 1.66 / 4 = 0.42 Gcal/ h turbine

The consumption of the electricity for lighting of BTW- 1 turbine section is determined bases on the estimate of 120 bulbs with 0.4 kW of power and 0.3 load factor.

$$N_{BTW-1}^{turb.l} = 120 \cdot 0.4 \cdot 0.3 = 14.4 \text{ kW},$$

Correspondingly for one turbine: 14.4/4=3.6 kW/turbine.

The consumption of the electricity for fans of BTW- 1 turbine section is estimated as:

$$N_{BTW-1}^{turb.f} = 8 \text{ kW}$$

The consumption of the electricity for lighting and fans of BTW- 1 turbine section will amounts to the following:

$$N_{BTW-1}^{turb.} = N_{BTW-1}^{turb.l} + N_{BTW-1}^{turb.f} = 14.4 + 8 = 22.4 \text{ kW}$$

The consumption of the electricity for lighting of BTW- 2 turbine section is determined bases on the estimate of 140 bulbs with 0.4 kW of power and 0.3 load factor.

$$N_{BTW-2}^{turb.l} = 140 \cdot 0.4 \cdot 0.3 = 16.4 \text{ kW},$$

Correspondingly for one turbine: 16.4/4=4.6 kW/turbine.

The consumption of the electricity for fans of BTW- 2 turbine section is estimated as:

$$N_{BTW-2}^{turb.f} = 12 \text{ kW}$$

The consumption of the electricity for lighting and fans of BTW- 2 turbine section will amounts to the following:

$$N_{BTW-2}^{turb.} = N_{BTW-2}^{turb.l} + N_{BTW-2}^{turb.f} = 16.4 + 12 = 28.8 \text{ kW}$$

In order to determine the electric energy per one turbine, it is necessary to divide total turbine sections consumption by the number of turbines.

$$N_{BTW\ 1}^{\text{ÏÒ -50,Ò-100}} = N_{BTW-1}^{turb.} / 4 = 22.4 / 4 = 5.6 \text{ kW/turbine}$$

$$Q_{BTW\ 2}^{\text{Ê -200}} = Q_{BTW-2}^{turb.} / 4 = 28.8 / 4 = 7.2 \text{ kW/turbine}$$

The electricity consumed for lighting of electric workshop include the following components:

1. The lighting of cable facility is carries out using 26 transformers 2.5 kW each. The total power is 26*2.5=64 kW

2. For the lighting of the rest of the electric workshop the incandescent lamps of ËÁ type, ÄÐË type of different power. The total power amounts to 12 kW.

3. For air circuits barkers the following compressors are installed at 220 kW ODE:

2 ÂÓÒ- 3/46 - 2 pieces- 45 kW
ÂØ - 3/40M - 3 pieces - 40 kW
3ÂØ - 1 - 1 pieces - 30 kW

The consumption of the electric energy for mentioned 6 compressors considering 0.5 of the use (activity) factor, is as follows:

$$N_{comp}= 0.5(2*45+3*40+30)=120 \text{ kW}$$

4. The heating of 220 kW ODE is carried out using electric heaters, the total power of which is 82 kW.
5. Total consumption of electricity at the electric workshop $N_{el.}$, is as follows:

for the winter 65+12+120+82 = 279 kW
for the summer 65+12+120 = 197 kW

Total consumption of the thermal energy for heating of the electric equipment repair workshop calculated based on the volume of the buildings is:

$$Q_{comp}=0.187 \text{ Gcal/h}$$

The consumption of the electric and thermal energy is attributable to the block and non-block units of the TPP, correspondingly to their installed electric capacity. The installed electric capacity of the TPP is 1110 MW, out of which 710 MW is for block part, and 300 MW for non-block part.

The consumption of the electricity in the block part and per the turbine is as follows:

$$\text{winter: } 810/1110 \cdot 279 = 204 \text{ kW}, N_{el}^{k\text{-}200} = 204 / 4 = 51 \text{ kW/turb.}$$

$$\text{summer: } 810/1110 \cdot 197 = 144 \text{ kW}, N_{el}^{k\text{-}200} = 144 /4 = 36 \text{ kW/turb}$$

The consumption of the electricity in the non-block part and per the turbine is as follows:

$$\text{winter: } 300/1110 \cdot 279 = 75 \text{ kW}, N_{el}^{\text{ÏÒ-50,Ò-100}} = 204 / 4 = 51 \text{ kW/turb.}$$

$$\text{summer: } 810/1110 \cdot 197 = 144 \text{ kW}, N_{el}^{\text{ÏÒ-50,Ò-100}} = 144 /4 = 36 \text{ kW/turb}$$

Consumption of the thermal energy:

for block part: 810/1110*0.187 = 0.136 Gcal/h,

$$Q_{el}^{k\text{-}200} = 0.136/4=0.034 \text{ Gcal/h turb.}$$

for non-block part: 300/1110*0.187 = 0.051 Gcal/h,

$$Q_{el}^{\text{ÏÒ-50,Ò-100}} = 0.051/4=0.013 \text{ Gcal/h turb.}$$

Turbine section and electric workshop consumption per one turbine is as follows:

$$Q^{\text{ÏÒ-50,Ò-100}} = Q_{\text{îî² -1}}^{\text{ÏÒ-50,Ò-100}} + Q_{el}^{\text{ÏÒ-50,Ò-100}} = 0.26 + 0.013 = 0.273 \text{ Gcal/h turb.}$$

$$Q^{K-200} = Q^{K-200}_{\text{î î ² -2}} + Q^{K-200}_{el} = 0.42 + 0.034 = 0.454 \text{ Gcal/h}$$

during the winter $N^{\text{ÏÒ-50,Ò-100}} = N^{\text{ÏÒ-50,Ò-100}}_{\text{î î ² -1}} + N^{\text{ÏÒ-50,Ò-100}}_{el} = 5.6 + 19 = 24.6$ kW/turbine

$N^{k-200} = N^{k-200}_{\text{î î ² -2}} + N^{k-200}_{el} = 7.2 + 51 = 58.2$ kW/turbine

during the summer $N^{\text{ÏÒ-50,Ò-100}}_{el} = 5.6 + 13 = 18.6$ kW/turbine

$N^{k-200} = 7.2 + 36 = 43.2$ kW/turb.

Attachment 7

The calculation of the electric and thermal energy consumption of the fuel-handling facility per back-up boilers

The consumption of the electric energy of the fuel-handling facility is presented in the Table A3.

Table A3

N	Name of the equipment	Type	Electric power	Actual power	Note load
			kW	kW	%
1.	1-st level mazout pump	8 HD 6x1	90	67.5	75
2.	2-st level mazout pump	8 HD10x5	500	150	30-(winter)
3.	Cold circulation mazout pump	8 HD 6x4	90	67.5	75
4.	N 1 Øä drainage pump	4 HD	20	6	30
5.	N 2 Øä drainage pump	P3 - 60	10	3	30
6.	N 3 Øä boiler pump	4K -8	18	13.5	75-(winter)
7.	Boiler pump of admin. building	4K -8	18	13.5	75-(winter)
8.	Mazout removal pump	P3 - 60	5	1.5	30
9.	Øä fans	-	6	1.8	30
10.	Lighting of the heat quarter	-	17	5	30
11.	N 3 Øä drainage pump	-	10	3	30

Total , $N_{fuel.}$

summer – 155.3 kW

winter – 332.3 kW

The consumption of the thermal energy to heat the mazout of the fuel handling facility, Q^{maz}_{fuel}, is accepted based on the (12) and amounts to the following:

for summer season – 0.024 Gcal/h,
for winter season – 0.038 Gcal/h

The consumption of the thermal energy to heat the fuel workshop is as follows:

$$Q^{heat}_{fuel} = q_h V (t_i - t_o), \text{ kcal/h,}$$

q_h= 0.4 kcal/m^3 h ^{o}C – building specific heat specification,
V = 2880 m^3 – volume of the building,
t_o = = -5 ^{o}C – outside temperature during the heating period,
t_I = +16 ^{o}C – building inside temperature.

The consumption of the thermal energy for hot water supply is :

$$Q_{fuel}^{hw} = G^{hwç} \ \Delta i_{hw}, \text{ kcal/h,}$$

where G^{hw} – water consumption of hot water supply depending on the number of sinks and showers

Δi_{hw} = 50 kcal/kg – consumption of thermal energy per 1 kg of hot water,
for 5 sinks:
Q_{fuel}^{hws} = 5*60*50=15000 kcal/h = 0.015 Gcal/h
for 3 showers:
Q_{fuel}^{hwsh} = 3*270*50=40500 kcal/h = 0.041 Gcal/h

For hot water supply, the consumption of thermal energy for 5 sinks and 3 showers with 0.3 use factor is:
Q_{fuel}^{hw} =0.3 (Q_{fuel}^{hws} + Q_{fuel}^{hwsh}) = 0.3 (0.015+0.041)=0.017 Gcal/h.

Total consumption of the thermal energy for the fuel handling facility is:

for winter season - $Q_{fuel} = Q_{fuel}^{maz.} + Q_{fuel}^{hl} + Q_{fuel}^{hw} = 0{,}038 + 0{,}024 + 0{,}017 = 0{,}079\ Gcal/h$,

for summer season - $Q_{fuel} = Q_{fuel}^{maz.} + Q_{fuel}^{hw} = 0{,}024 + 0{,}017 = 0{,}048\ Gcal/h$:

The consumption of electric and thermal energy in the fuel handling facility is attributable to the boilers relative to their productivity:
For ? ? ? 320 type boiler by 320/4160,
For ? ? ? type boiler by 640/4160 (as presented in the attachment 5).

The consumption of the electricity per one boiler is:

winter - $N_{\text{fuel}}^{\text{ÁÊÇ -320}}$ = 320/4160 · 332.3 = 25.6 kW

summer $N_{\text{fuel}}^{\text{ÒÃÌ -104}}$ = 640/4160 · 332.3 = 51.1kW

The consumption of the thermal energy per one boiler of fuel handling facility is:

winter $\text{Q}_{\text{fuel}}^{\text{ÁÊÇ -320}}$ = 320/4160 · 0.079 = 0.006 Gcal/h,

$\text{Q}_{\text{fuel}}^{\text{ÒÃÌ -104}}$ = 640/4160 · 0.079 = 0.012 Gcal/h,

summer $\text{Q}_{\text{fuel}}^{\text{ÁÊÇ -320}}$ = 320/4160 · 0.048 = 0.004 Gcal/h,

$\text{Q}_{\text{fuel}}^{\text{ÒÃÌ -104}}$ = 640/4160 · 0.048 = 0.007 Gcal/h,

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